Aerosol chemical composition and source characterization during 2008 VOCALS REx

-Preliminary Results-

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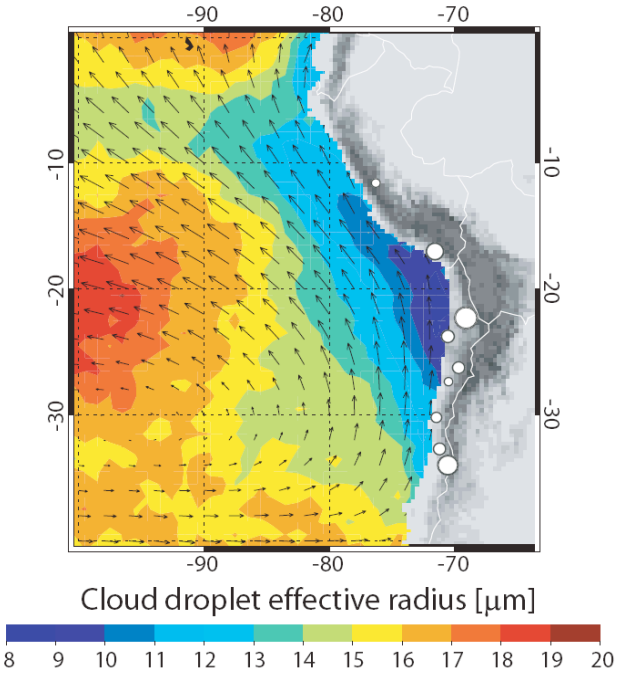
- VOCALS SEP REx: Scientific Program Overview -

***Hypothesis 1c**: The small effective radii measured from space over the SEP are primarily controlled by anthropogenic, rather than natural, aerosol production, and that entrainment of polluted air from the lower free-troposphere is an important source of cloud condensation nuclei (CCN).*

Goal: To identify the sources of these particles by measuring the key tracer constituents



Natural:

- sulfate and methanesulfonate from ocean-emitted DMS
- dust from arid land in the region
- sea-salt

Anthropogenic:

- power plants and smelters
- urban emissions
- Agricultural activities

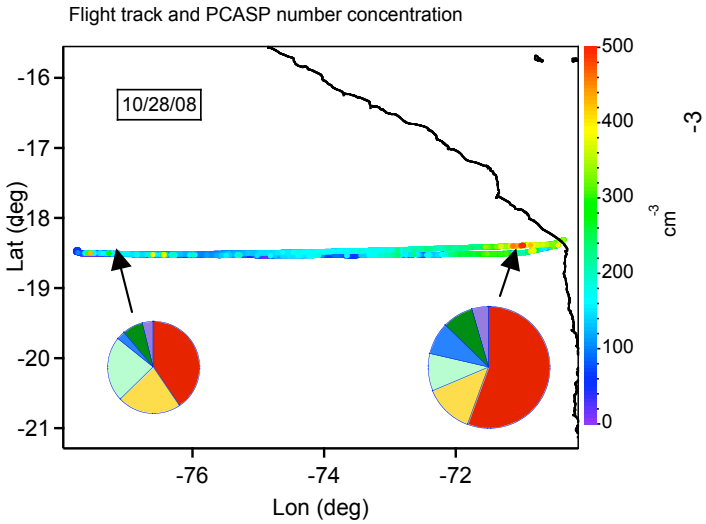
AMS and PILS-IC were deployed on the DOE G-1 to determine aerosol chemical composition and source identification
(PTR-MS was used for determining VOC and DMS)

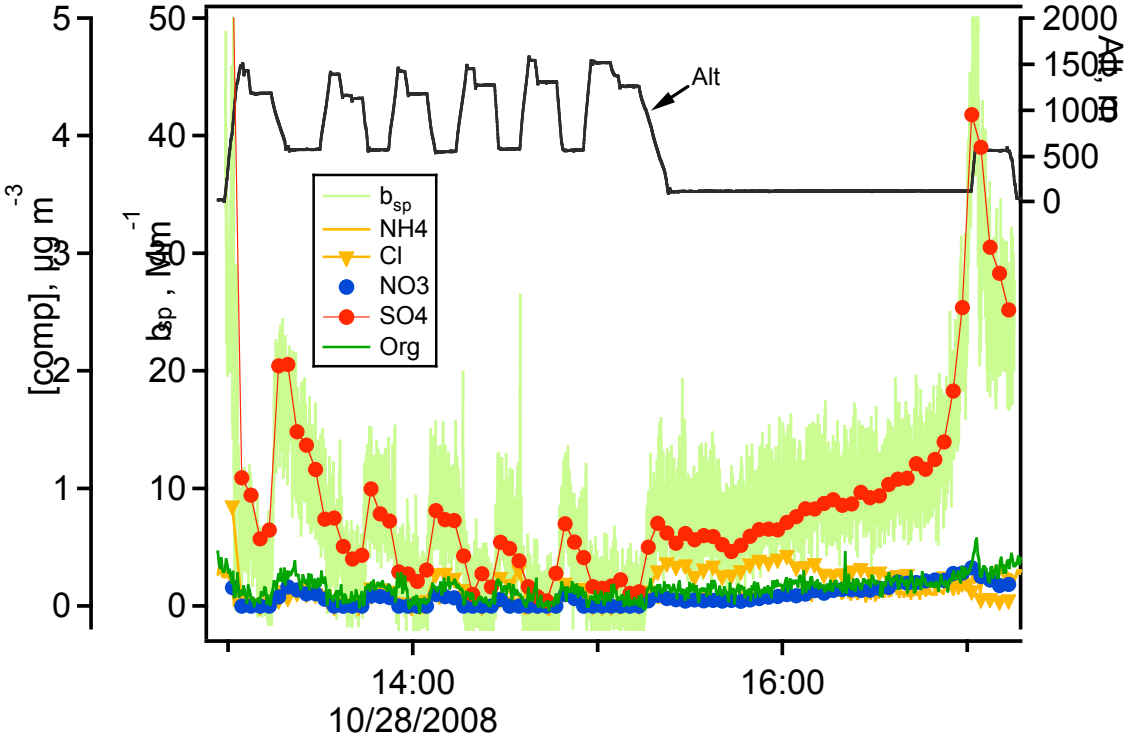
	MARINE		**TERRESTRIAL**		
Technique	***Sea-Salt***	***DMS products***	***Agriculture, Biomass Burning***	***Urban, Power plants, Smelters***	***Dust***
PILS-IC (0.08 µm – 1.5 µm, bulk; 3.0 min)	***Na^+***, Cl^-, Mg^{2+}	***$CH_3SO_3^-$***, SO_4^{2-}	***K^+***, NH_4^+	***NO_3^-***, SO_4^{2}, NH_4^+	***Ca^{2+}***, ($NaNO_3$)
cToF-AMS (0.06 µm– 0.6 µm, size-resolved; 20 sec)		***$CH_3SO_3^-$***, SO_4^{2-}	NH_4^+, Org	***NO_3^-***, SO_4^{2}, NH_4^+, Org	

Preliminary Data

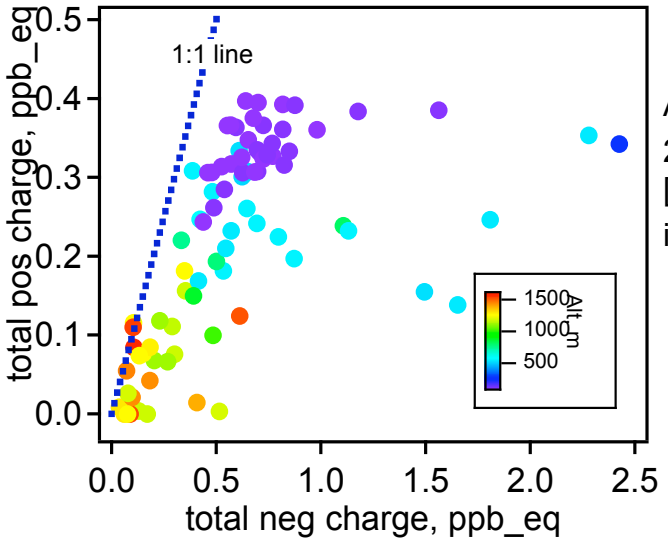
MBL aerosol chemical composition observed on the flight of 10/28/2008 show:

- ***SO_4^{2-}** dominated, decreasing with distance from land*
- ***NaCl** was comparable to SO_4^{2-} away from the coast*
- ***Organics, NO_3^-, and NH_4^+** were minor, all less than 10% of SO_4^{2-}*
- ***$CH_3SO_3^-$** was only occasionally observed, but always below 0.1 μg/m³*
- ***K^+ and Ca^{2+}** were nearly always below 0.15 μg/m³*

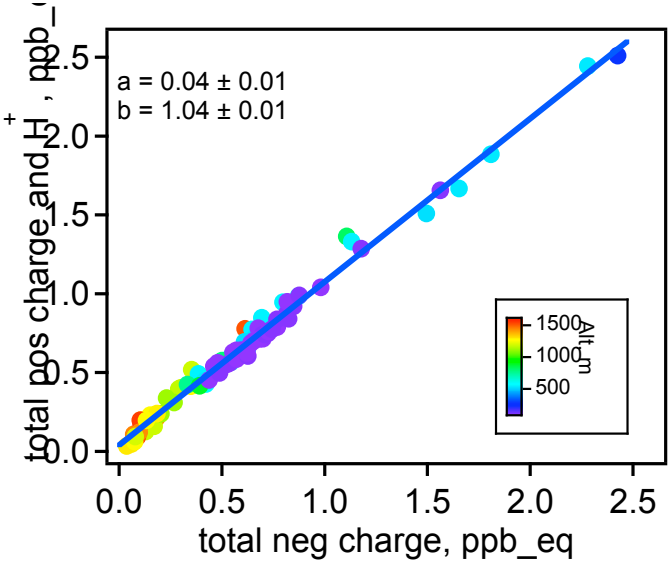


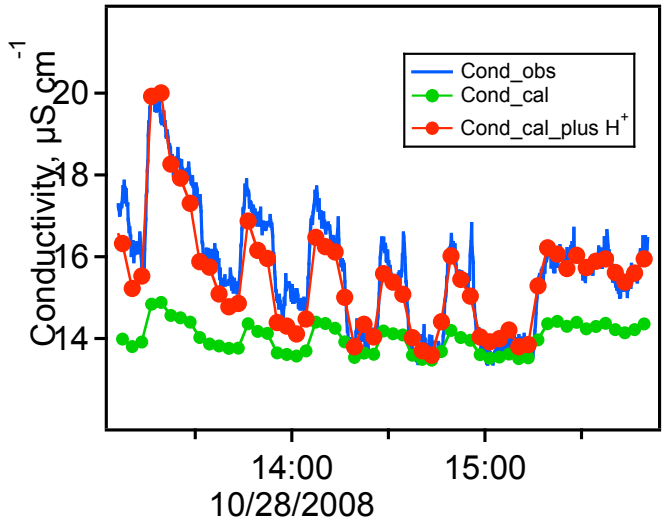


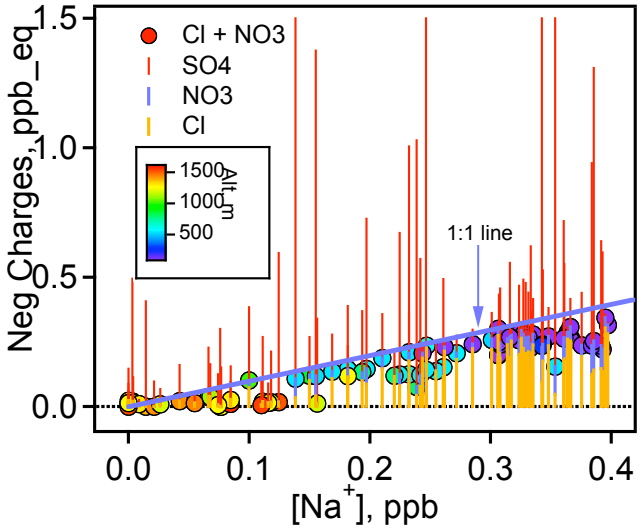
SO_4^{2-} aerosols were strongly acidic and externally mixed with the modified sea-salt particles



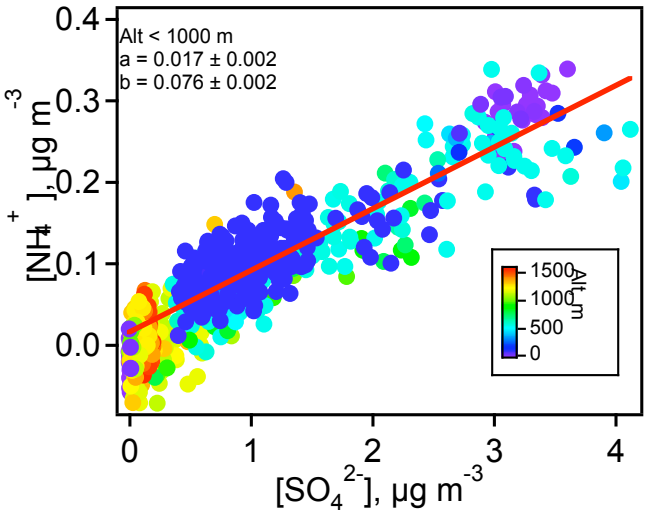
Add
2*nss[SO_4^{2-}]-[NH_4^+]
in ppb to ordinate

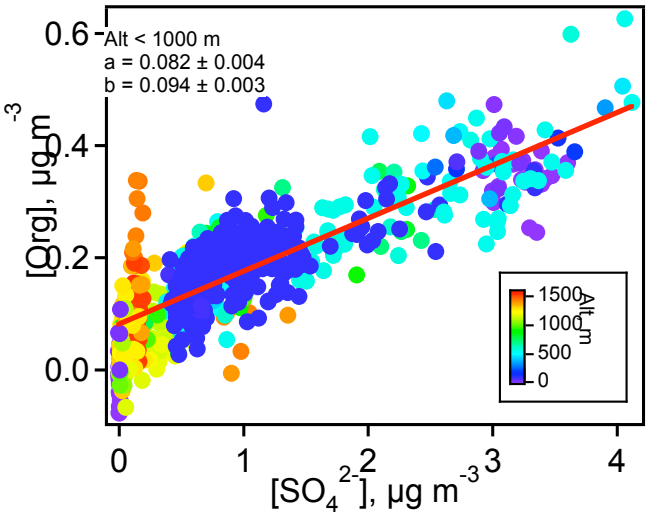


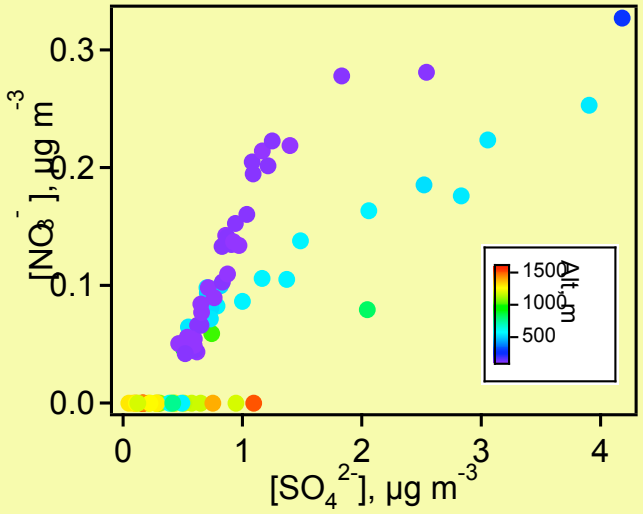




Org, NH_4^+, and NO_3^- were correlated with SO_4^{2-}, suggesting common source attributes and terrestrial origin





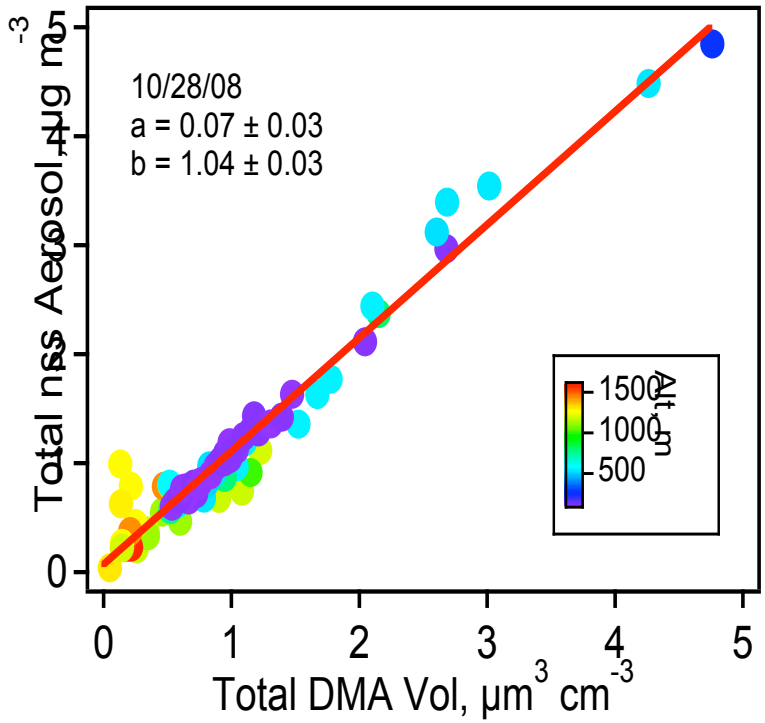


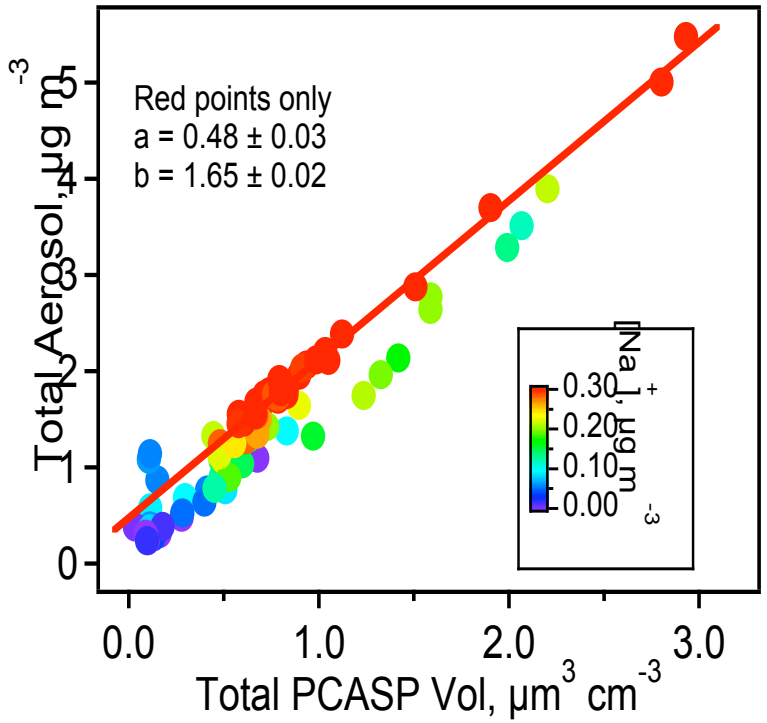
The altitude dependent slopes above are consistent with the facts:

- Sea-salt particles on which NO_3^- deposits are externally mixed with SO_4^{2-} aerosols
- Sea-salt particles have a stronger vertical gradient than SO_4^{2-} particles

Aerosol properties inferred from comparing mass concentrations with DMA and PCASP volumes

- Tight correlation below suggests the D_p of nss-aerosol particles were smaller than ~0.45 µm.
- The near unity slop indicates DMA volume included the water present in SA aerosols (cf. DMA RH = ~13-16% at which the corresponding H_2SO_4 growth factor is ~1.2).
- A strong correlation between mass concentration and PCASP volume, especially for sea-salt containing particles, gives no indication of missing mass due to dust particles (for D_p < ~1.5 µm).





Tentative Conclusions

- MBL aerosol was dominated by sulfuric acid (SA) and sea-salt (SS) aerosol particles, which were found externally mixed.
- SA aerosols are anthropogenic because of
  - a land-water concentration gradient
  - good correlation with organics and NO_3^-
  - limited contributions from DMS based on low concentrations of $CH_3SO_3^-$ and DMS
- SA aerosol sizes are small with D_p < ~0.5 μm
- SS particles were acidified by HNO_3 as well as H_2SO_4 showing Cl^- deficits.
- No indication of appreciable dust particles with D_p < 1.5 μm.

NOT so tentative:

- *Knowledge of aerosol chemical composition is needed for understanding:*
  - *CCN properties*
  - *Aerosol direct radiative effects*

    Both of which require good size information which in turn depends on chemical information
  - *Aerosol-cloud interactions*
  - *Chemical transport and source attributions*